

Remote Monitoring of Vital Signs Using Doppler Radar

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An estimated 100 million Americans suffer from chronic health conditions related to heart disease, lung disorders, and diabetes. The cost of caring for these patients consumes a full 75 percent of the total U.S. healthcare costs. A significant portion of that cost comes from the expense of monitoring patients and transferring the recorded data to physicians for evaluation. It is readily apparent that if remote sensing and telecommunication were an option, this would represent a significant savings to the health care bill.

Microwave Doppler radar of respiratory, cardiac and arterial movements was effectively demonstrated in the late 1970's, using X-band Doppler transceivers. But even into the 1980's, the portable versions were too bulky. After many iterations of Moore's law, (the law that suggests that processor speeds will double every 18 months) processing speeds and chip size allow today's digital signal processors (DSPs) to handle the massive algorithms necessary to separate and filter the signals that correspond to respiration and heart rates. Doppler theory states that a constant frequency signal that reflects off a surface that is itself varying its displacement, i.e. moving, will result in a reflected signal at the same frequency but with a time varying phase. That is, the reflected signal is phase modulated (PM). The difficulty in obtaining a heart rate can be easily understood when consideration is given to the movement

of the torso due to respiration. However, these movements can be effectively filtered using software driven algorithms at speeds that easily allow for a sample rate of 50 samples per second.

Preliminary trials have shown success rates of 94 percent in recovering heart rate signals at a distance of two meters. (Success has been defined as being within 2 percent of the reference signal.) These trials, using a 2.4GHz carrier wave, take samples in blocks of 20 to 25 seconds. The sample rates vary from 25 to 50 samples per second, yielding as many as 1250 data points per interval. Because the data is already digitally encoded, transmission of this data can be easily accommodated using existing data telecommunication networks.

In addition to the applications previously described, this type of non-contact radar technique would prove a welcome alternative to those patients suffering from hypersensitivity to traditional vital sign monitoring, such as burn patients and severe tissue trauma patients.

The success of this technology begins a new era in defining truly non-invasive diagnosis, where non-invasive means non-contact. Further, doctors can exchange information regarding diagnosis and treatment based on vital sign information from anywhere in the world with just a click of the mouse. And best of all, no more frigid stethoscopes!